United States General Accounting Office

GAO

Report to the Honorable Duncan Hunter
House of Representatives

September 2000

BORDER PATROL

Procurement of MD 600N Helicopters Should Be Reassessed

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United States General Accounting Office
Washington, D.C. 20548

General Government Division

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September 29, 2000

The Honorable Duncan Hunter
House of Representatives

Dear Mr. Hunter:

The U.S. Border Patrol, part of the Immigration and Naturalization Service (INS), is procuring a new type of helicopter—the MD 600N—as part of a replacement program for its aging helicopter fleet. The MD 600N was intended to be suitable for a variety of Border Patrol air operations missions and scenarios. However, many Border Patrol pilots operating the first MD 600Ns expressed concerns about the safety and suitability of the aircraft for key mission applications. On the basis of these concerns, you asked us to review the MD 600N's procurement, application, and suitability for Border Patrol use.

Specifically, we agreed to provide information and analysis on (1) procurement of the MD 600N, including procurement specifications and selection factors and (2) whether experience has shown the MD 600N helicopter to be effective in safely supporting the Border Patrol's primary air operations mission. We also agreed to provide information on the Border Patrol 's air operations missions and resources.

Results in Brief

The INS procurement in which the MD 600N helicopter was selected for the Border Patrol was intended to provide an aircraft capable of meeting a variety of air operations requirements, such as low and slow surveillance and transport of agents and mission equipment. To obtain such a multipurpose aircraft, the contract solicitation listed three minimum performance criteria the aircraft needed to have. The aircraft was required to operate at a speed of up to 130 knots, operate at high altitude with crew and equipment outlined by the statement of work, and be capable of operating at least 2 hours under normal conditions. The aircraft was also required to have seating for two pilots and two passengers. Only two aircraft were determined to be within the competitive range under these specifications.

Some weaknesses were noted with both of the aircraft, although overall both were considered acceptable. The flight evaluation team for the procurement reported that flying the MD 600N was a heavy workload—controls were stiff, yet needed constant adjustments to fly. The team also

reported that the cockpit was cramped, particularly during night flight with additional equipment. The contract was awarded to McDonnell Douglas Helicopter Systems (which later became MD Helicopters, Inc.)[1] based on best value to the government. The Border Patrol has purchased 11 of these helicopters for about $1.3 million each. The contract contains options to purchase up to 34 additional helicopters over a 4-year period. A funding request for new Border Patrol helicopters is included in the fiscal year 2002 Department of Justice budget request.

Most Border Patrol pilots who have had experience flying the MD 600N and most sector chiefs expressed strong reservations about the suitability of the helicopter for supporting key air operations missions. In particular, the pilots reported that the MD 600N is inferior to the smaller aircraft being replaced for low-level, low-speed surveillance—which is a large portion of the overall mission profile. The pilots were concerned about the safety of the MD 600N, citing difficulty in performing emergency procedures and with other documented problems, such as malfunctioning of the engine control system and defective control cables. The pilots also said that the MD 600N is generally difficult to operate and fatiguing to fly. Two of the three local law enforcement agencies with MD 600Ns that we spoke with shared many of these concerns.

The amount of time the MD 600N helicopters were unavailable because of maintenance-related reasons also was a concern to pilots, mechanics, and most Border Patrol sector chiefs. Border Patrol Air Operations records show the aircraft was unavailable about 50 percent of the time between December 1998 and March 2000. Reasons for the downtime included delays in obtaining an engine repair contract, slow manufacturer approval for modifications, and parts availability.

Responding to our inquiry regarding these concerns, the current manufacturer of the MD 600N, MD Helicopters Incorporated (MDH), stated that all known problems with parts or components have been or will be corrected. Company officials believed that the concerns the Border Patrol pilots have had regarding the MD 600N are typical of those encountered with a new product. MDH has proposed modifications to the helicopter to make it easier and less fatiguing to fly. A major handling improvement being considered—the addition of a stabilization system—may greatly improve handling concerns. However, this and other proposed changes do not address all of the concerns surrounding the limited availability, safety,

[1] Since the contract was signed, McDonnell Douglas Helicopter Systems has been sold twice. It was first bought by the Boeing Company in 1997 and later by MD Helicopters, Inc., in 1999.

or suitability for certain missions. Regarding the availability of the helicopter, an MDH official said that there is no reason that the Border Patrol aircraft should have so much downtime.

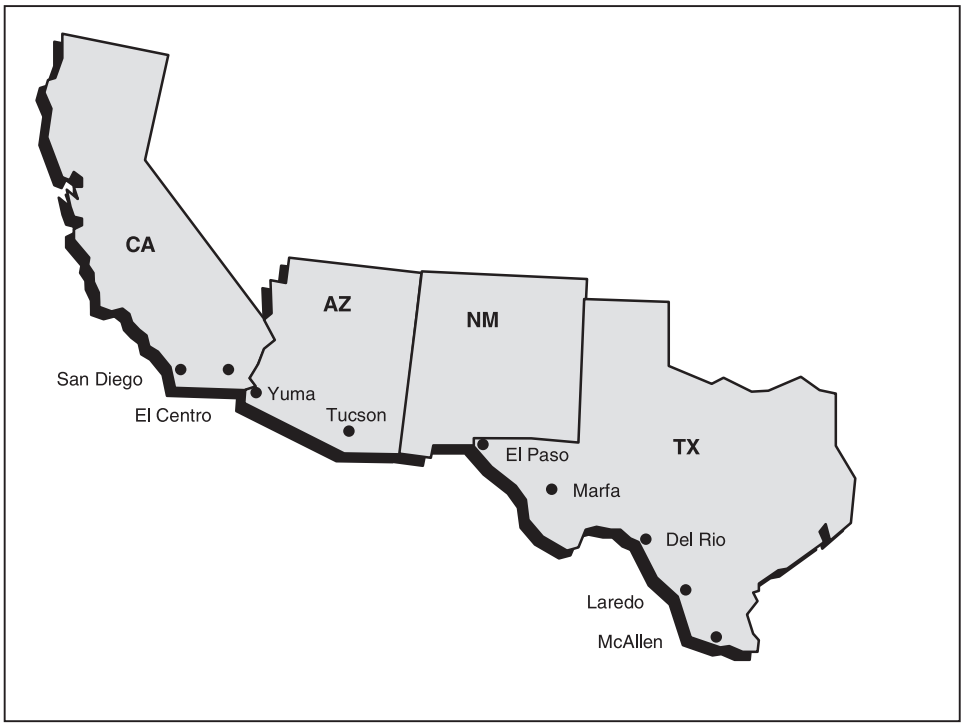
The Chief of the Air Operations support office also believed that the problems encountered with the MD 600N can be addressed and that pilots will become accustomed to flying it. However, based on the problems they have encountered, and after almost 2 years of experience with the helicopter, most pilots, mechanics, and sector chiefs do not support acquiring more MD 600Ns for the Border Patrol fleet. Moreover, most sector chiefs have also questioned the appropriateness of acquiring a multipurpose aircraft to meet the individual needs in each sector.

We are recommending that before any more MD 600Ns are purchased, Border Patrol officials and MDH address the safety, handling, and availability issues raised by pilots and mechanics. We are also recommending that the Border Patrol reassess its decision to purchase one type of multipurpose helicopter to meet a variety of air operations requirements. In its comments, INS concurred with these recommendations and provided additional information, which we evaluated and incorporated, as appropriate.

Background

The Border Patrol is the mobile, uniformed, enforcement arm of the INS. Its mission is to detect and prevent the smuggling and illegal entry of undocumented aliens into the United States and to apprehend persons found in the United States in violation of immigration laws. Border Patrol agents perform their duties by land, sea, and air near and along about 8,000 miles of U.S. boundaries. The Border Patrol is divided into 21 sectors, 9 of which are along the southwest border. Sectors are further subdivided into stations. Each sector is headed by a chief patrol agent, herein referred to as the sector chief. The sector chief controls both ground and air resources in their particular sector.

Figure 1: Border Patrol Sector Headquarters Along the Southwest Border



Source: U.S. Border Patrol.

From fiscal year 1992 to fiscal year 2000, funding for the Border Patrol has increased from $362 million to over $1 billion (in constant dollars). At the end of fiscal year 1999, there were 8,225 Border Patrol agents on duty and deployed, as compared with 7,856 at the end of fiscal year 1998.

Border Patrol air operations support the overall agency mission using aerial equipment to detect and monitor illegal alien traffic while assisting enforcement activities. One primary air operations mission consists of border monitoring activities to detect evidence of, or illegal entry of aliens, alien smugglers, contraband, and violators of other laws. According to Border Patrol officials and documents, their mission requires aircraft that can fly for extended periods at low altitudes and speeds. In some Border Patrol sectors, low altitude and slow speed flying can account for as much as 90 percent of flight time.

Aircraft also provide (1) rapid response to remote intrusion detection sensors, (2) assistance for humanitarian missions in remote locations, and (3) the capability to observe and coordinate law enforcement activities over large geographic areas. Using technology, including forward looking

infrared (FLIR) and night lighting systems, aircraft also provide detection and safety capabilities that are not otherwise available. The primary aircraft used by the Border Patrol to meet the mission requirements for border control efforts, low altitude detection of cross border violators and close ground/agent support has been rotary wing aircraft—helicopters.

Support for air operations, such as the provision of equipment, training and supplies is provided by the Air Operations Center in El Paso Texas. The Air Operations Chief directs air operations. The Border Patrol aircraft fleet currently consists of 57 helicopters and 27 airplanes in 19 locations around the country—primarily in the nine sectors on the southwest border, as shown in table I. Over half of the helicopters are 35 year-old military surplus OH-6A craft, which are the light weight category aircraft. The Deputy Air Operations Chief described a need for helicopters in the light, mid-range and utility categories. The bulk of the Border Patrol's work is in the light category.

Table 1: Border Patrol Aircraft Fleet and Locations Along the Southwest Border

Sector	Aircraft make	Model	Number of aircraft	Classification	Number of pilots
San Diego, CA	Hughes	OH-6A	3	Helicopter	18
	McDonnell Douglas	MD 500 E	4	Helicopter	
	McDonnell Douglas	MD 600N	3	Helicopter	
	Bell	UH-1H	1	Helicopter	
El Centro, CA	Cessna	C-182	1	Airplane	5
	Piper	PA18	3	Airplane	
	Hughes	OH-6A	3	Helicopter	
	McDonnell Douglas	MD 500C	1	Helicopter	
Yuma, AZ	Cessna	C-182	1	Airplane	6
	Hughes	OH-6A	4	Helicopter	
Tucson, AZ	Cessna	C-182	1	Airplane	7
	Piper	PA18	1	Airplane	
	Hughes	OH-6A	4	Helicopter	
El Paso, TX	Cessna	C-182	1	Airplane	8
	Hughes	OH-6A	5	Helicopter	
	McDonnell Douglas	MD 600 N	1	Helicopter	
El Paso Air Operations Training Center	Cessna	C-210	2	Airplane	7
	Hughes	OH-6A	3	Helicopter	
	McDonnell Douglas	MD 600N	1	Helicopter	
	Bell	UH-1H	1	Helicopter	
Marfa, TX	Cessna	C-206	1	Airplane	6
	Piper	PA18	1	Airplane	
	Hughes	OH-6A	3	Helicopter	
Del Rio, TX	Cessna	C-206	1	Airplane	11
	Piper	PA18	3	Airplane	
	Eurocopter (A-Star)	AS350BA	4	Helicopter	
	Hughes	OH-6A	1	Helicopter	

Sector	Aircraft make	Model	Number of aircraft	Classification	Number of pilots
Laredo, TX	Bell	UH-1H	1	Helicopter	
	Cessna	C-182	1	Airplane	6
	Piper	PA18	1	Airplane	
	Hughes	OH-6A	1	Helicopter	
McAllen, TX	McDonnell Douglas	MD 600N	3	Helicopter	
	Cessna	C-206	1	Airplane	11
	Cessna	C-182	1	Airplane	
	Piper	PA18	1	Airplane	
	Hughes	OH-6A	3	Helicopter	
	McDonnell Douglas	MD 600N	3	Helicopter	

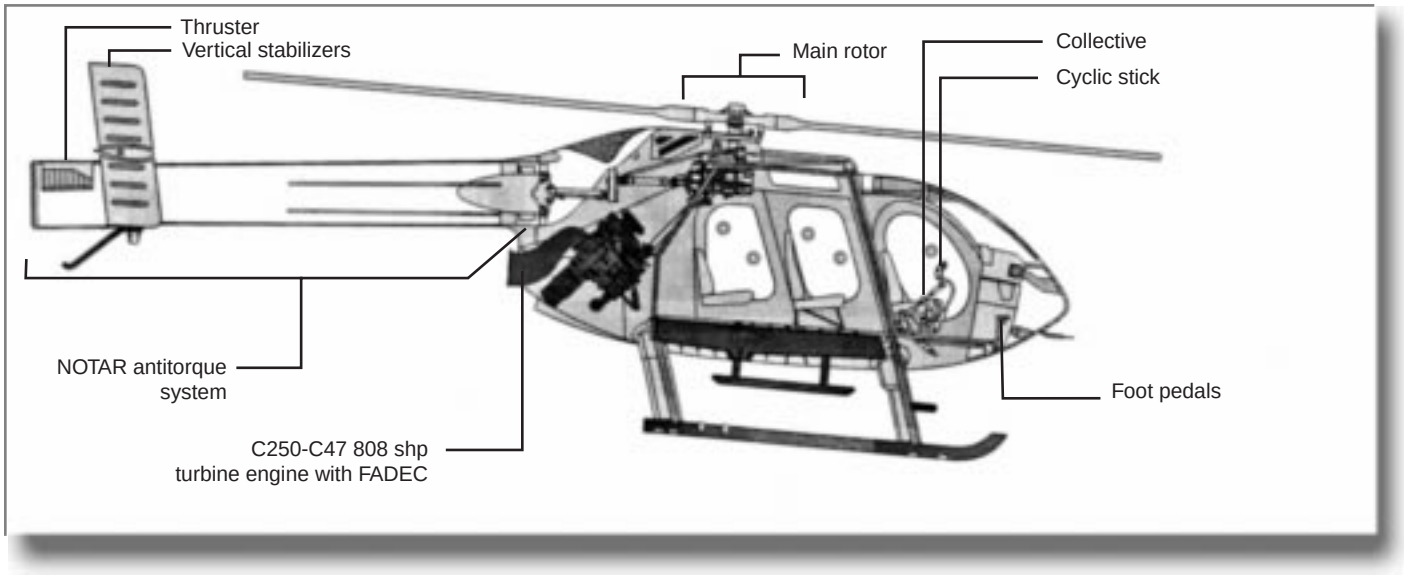
Note: Data is current as of June 2, 2000.

Source: U.S. Border Patrol.

Helicopter Primer

Helicopters operate using an engine to power the main rotor blades, with the blades working much like the wings on an airplane produces lift. The force of the main rotor turning in one direction has the effect of turning the fuselage (i.e., body) of the helicopter in the opposite direction. To cancel the "torque" or spin created by the main rotor, conventional helicopters have a tail rotor that opposes the main rotor torque tendency. The MD 600N differs from the conventional model by using an antitorque system that that does not use a tail rotor called a NOTAR system.

Figure 2: MD 600N Flight Controls



Source: GAO analysis of MD helicopters' materials.

Pilots simultaneously use three different controls to operate a helicopter in a coordinated fashion or "in trim."

- The cyclic control allows the pilot to change the angle or tilt of the rotor blades to control the forward, backward, and sideways direction of the helicopter.
- The collective is the primary control for the up and down action of the helicopter. The collective varies the lift produced by the main rotor by changing the pitch of the blades at one time or collectively.
- The foot pedals in both NOTAR and conventional helicopters control the antitorque action, and control left and right turns when hovering. The pedals control the pitch of the fan, vertical stabilizers, and thruster of the NOTAR system. The right pedal decreases the antitorque action, while the left pedal increases it.

Movement with one control often requires a corresponding move in other controls to coordinate flight. For example, when the collective is moved so there is less lift, the torque is reduced and the right pedal must be adjusted to maintain flight. To operate properly, a helicopter must also have its weight balanced around a center of gravity and be within weight limits.

Objectives, Scope, and Methodology

Our objectives were to provide information and analysis on (1) procurement of the MD 600N, including procurement specifications and selection factors; and (2) whether experience has shown the MD 600N helicopter to be effective in safely supporting the Border Patrol's primary air operations mission. We also were to provide information on the Border Patrol's air operations missions and resources.

Information on the mission of Border Patrol air operations was obtained from INS officials and other documents as well as from interviews with key Border Patrol and Air Operations officials.

To analyze the procurement of the MD 600N, we reviewed procurement files at the INS Contracting and Procurement Branch in Dallas, Texas. The documents reviewed included the source selection plan, the technical evaluation, business evaluation, the contract, and contract modifications. We also reviewed acceptance the documents for each the MD 600Ns received by the Border Patrol. We spoke with the head of the technical evaluation team as well as pilots and mechanics who tested the MD 600N and other competing helicopters.

To obtain information on experience with the Border Patrol's MD 600Ns, we interviewed pilots and mechanics in the four sectors with MD 600Ns

(San Diego, CA; McAllen, TX; Laredo, TX; and El Paso's substation in Deming, NM). We interviewed 25 of the 29 pilots then certified to fly the MD 600N and 3 of the 4 training pilots. We met with the 12 mechanics that were available in the 4 sectors. Pilot and mechanic interviews were conducted in both group settings and individually.

For Border Patrol management's views on the issues surrounding the MD 600N, we interviewed Air Operations senior managers and the chief or assistant patrol agent (sector chief) in each of the Border Patrol sectors where the MD 600Ns are operated. We also reviewed correspondence on the MD 600N between Border Patrol pilots, sector chiefs, and Air Operations. We examined training materials for the MD 600N used by Border Patrol instructors.

We interviewed MDH officials and reviewed MDH technical documentation for the MD 600N, such as the flight training manual and descriptive brochures. We examined MD 600N warranty service requests and manufacturer's service notices.

To more fully understand the performance of the MD 600N, we held discussions with Federal Aviation Administration (FAA) aircraft certification officials in Los Angeles, and a National Transportation Safety Board (NTSB) official. We also reviewed NTSB Aviation Accident Database records on the MD 600N and other helicopters for comparison purposes. We also talked to all three other U.S. law enforcement agencies operating the MD 600N: the Los Angeles, Orange County and San Bernardino Sheriffs offices, about their experience using the MD 600N helicopter.

We conducted our review between March 2000, and August 2000, in accordance with generally accepted government auditing standards.

MD 600N Procurement Is Intended to Meet Wide Range of Requirements

The MD 600N helicopter contract is intended to provide a multipurpose aircraft capable of meeting Border Patrol requirements for a variety of missions and scenarios, such as low and slow surveillance and transport of agents and mission equipment. The flight evaluation of the MD 600N, which was conducted during the competition for the contract, noted several flight-related weaknesses, including stiff controls that may contribute to fatigue during typical low-level Border Patrol operations and a cramped cockpit that could impede night operations. Notwithstanding those weaknesses, the contract was awarded to McDonnell Douglas

Helicopter Systems (which later became MD Helicopters, Inc.)[2] because its proposal to supply the helicopters represents the best overall value. The Border Patrol has purchased 11 MD 600N helicopters for about $1.3 million each and, under the contract, could buy up to 34 more.

Procurement for a Multipurpose Aircraft

According to Air Operations officials, air operations requirements were established based on information provided by Border Patrol sectors. These requirements varied by sector and included needs such as low and slow flight operations, long-range and improved night operations capabilities. Initially, the intent was to replace the lightweight OH-6A helicopters, but this approach was dropped in favor of a multimission aircraft that could meet a range of needs, a Deputy Chief said. The INS solicitation asked for an aircraft to cover as many contingencies as possible. Missions include long periods of surveillance at one location; surveillance over long distances at minimum airspeeds; mountain operations; night surveillance, using vision enhancement equipment; and transportation of agents and/or mission equipment to remote sites. Air operations are conducted from sea level up to 5,500 feet and in temperatures ranging from below freezing up to 120 degrees.

On January 16, 1997, the INS issued the solicitation to procure a multipurpose helicopter capable of operating in a wide range of Border Patrol scenarios. The solicitation was for the acquisition of up to 45 light observation helicopters and associated spare parts, technical support, and parts exchange and overhaul support. The solicitation was issued under the commercial items and negotiated procurement procedures of the Federal Acquisition Regulation. The INS conducted the competitive acquisition under formal source selection procedures, including evaluation of technical proposals (a component of which was a flight evaluation of the helicopters themselves), past performance, and price.

Under the solicitation, technical merit and past performance were more important than price, although slightly superior technical capability and/or past performance would not justify a significantly higher price. The INS would make this assessment though a trade-off analysis that compared the benefits of superior technical capability and/or past performance with a higher price. Price could become the determining factor if proposals were judged equal and close to equal for technical merit and past performance.

[2] Since the contract was signed, the civilian helicopter line of McDonnell Douglas Helicopter Systems has been sold twice. It was first bought by the Boeing Company in 1997 and later by MD Helicopters, Inc., in 1999.

Proposed helicopters had to be the manufacturer's latest model and had to be certified by the FAA by the time of delivery.

The solicitation's statement of work contained three minimum performance criteria. These were for (1) a sustained high speed of 130 knots to reduce response time; (2) the capability to operate at high altitude at maximum gross weight[3] (a minimum of 6,000 feet); and (3) the capability of not less than 2 hours continuous flight time (with auxiliary fuel, 4 hours) at normal patrol operating speeds (40 to 60 knots) and weight. Desired (but not required) performance included having helicopter noise levels that did not exceed 84 decibels.

In addition to required aircraft performance, the solicitation specified certain weight and balance requirements. Requirements included

- the maximum ability to load the aircraft's cabin without having to move any aircraft components or use any movable ballast to keep within certified flight limitations; and
- a minimum capability of holding two pilots and one crewmember, carrying the maximum amount of fuel, and containing specialized equipment, such as a forward-looking infrared unit.

The solicitation also specified that the interior cabin configuration was required to have seating for two pilots up front (with dual controls) and a minimum of two passenger seats in the rear. Desirable interior cabin features, included padded seats and lumbar support for the pilots, and maximum soundproofing to reduce pilot and passenger fatigue and stress.

Evaluations Reduced Choice to Two Helicopter Proposals

Eight proposals offering different helicopter models were received from three companies in response to the January 1997 solicitation for new Border Patrol helicopters. One company, American Eurocopter, dropped out of the competition in March 1997. As part of the solicitation, the Border Patrol conducted a precontract award flight evaluation of six helicopters proposed by two firms. Four helicopters were found to be technically unacceptable (e.g.; for insufficient space to carry mission equipment) and were eliminated from further consideration. The two remaining helicopter models were the McDonnell Douglas Helicopter Systems MD 600N and the Bell Textron 407. The McDonnell Douglas Helicopter Systems and the Bell Textron proposals, while both initially

[3] Maximum gross weight includes accessories listed in the statement of work, maximum fuel and approximately 500 pounds of crew and equipment.

received a marginal technical evaluation rating, were considered as having a reasonable chance of being awarded the contract.[4]

The precontract award flight evaluation resulted in a tie between the MD 600N and the Bell 407—both were rated in the "better" category during flight tests.[5] The MD 600N was noted as being strong and as having good speed. Its unusual anti-torque system was assessed as a definite plus from a safety standpoint. The Bell 407 was noted for its superb handling characteristics and ample power for all Border Patrol mission requirements. The Bell 407 ample crew and equipment space, outstanding visibility and responsive controls were also rated as strengths.

Evaluators noted weaknesses, however, in both helicopters. The flight evaluation of the MD 600N identified weaknesses that included (1) the aircraft being hard to handle due to its size and weight; (2) the interior space being cramped; (3) the internal noise levels being high; and (4) the aircraft having stiff controls. Specifically, flight-test evaluators noted that during typical low-level Border Patrol operations, the MD 600N was hard to control due to its size and weight and that the control forces required to be used by the pilot for maneuvering the helicopter were extreme. Evaluators also noted that these problems could lead to pilot fatigue and stress that would be detrimental to crew safety. Pilots conducting the flight test noted that this condition "is unacceptable for Border Patrol operations at low level" and that a hydraulic system would help considerably. Further, the evaluators noted that the pilot and passenger cabins were small and tight and that the cramped cockpit impeded the pilot's freedom of movement during regular missions and, even more so, during night operations when either the forward-looking infrared equipment or night vision goggles were used.

Although not listed as a weakness, in their description of the MD 600N flight evaluation, evaluators stated that the manufacturer did not provide

[4] The general technical responses of both proposals were rated as marginal due to technical deficiencies and other noncompliance items that were not related to the flight evaluation. Specifically, the deficiencies were in the areas of the maintenance plan, training plan, and helicopter component parts. Upon review of the proposals and the solicitation language, source selection officials identified several areas where it could relax or otherwise change its requirements and still meet its mission and operational needs. The selection officials determined that it could amend the solicitation so as to make both "marginal" proposals acceptable and amended the solicitation accordingly. Both McDonnell Douglas and Bell had outstanding past performance.

[5] A "better" determination means that the competitor (1) meets all of the solicitation's minimum requirements and exceeds many of the requirements for a particular factor, subfactor, or overall or (2) exceeds a small number of the minimum requirements but does so to a significant degree or in a valuable way.

them with enough data to determine whether the aircraft could meet its endurance requirements. The flight evaluation of the Bell 407 identified as a weakness, among other things, that it did not meet the desired low noise levels the Border Patrol was seeking.

Following this initial evaluation and discussions with the government, McDonnell Douglas and Bell Textron both submitted best and final offers. Reviews of both offers by the technical evaluation committee continued to list the same flight-evaluation weaknesses noted earlier and did not note any corrective actions by either offeror. The technical evaluation committee noted, however, that best and final offers for the McDonnell Douglas and the Bell Textron proposals would meet or exceed requirements for Border Patrol air operations.

In selecting the MD 600N, the source selection evaluation board stated that while the two competitors essentially tied during the technical, flight test, and past performance evaluations, the MD 600N came in at a lower evaluated price than the Bell 407. Further, a best value trade-off analysis concluded that neither aircraft demonstrated technical superiority of such value as to warrant consideration of paying a premium price. Based on a July 30, 1997, evaluation board recommendation, the INS awarded the helicopter contract to McDonnell Douglas Helicopter Systems for the MD 600N because its proposal represented the best value to the government.

Border Patrol Could Purchase Up to 34 More MD 600N Helicopters

The Border Patrol purchased 11 MD 600N helicopters for about $1.3 million each—and could order up to 34 more helicopters, at agreed to higher prices—in the remaining 3 option years (2000 to 2002). An INS official told us that the INS has asked the Department of Justice, as part of it's fiscal year 2002 budget request, to include $13.5 million for nine replacement helicopters at $1.5 million each for the Border Patrol. The request does not specify the type of helicopter but notes that it will be a single-engine aircraft with a low-noise signature capable of performing the Border Patrol's air operations surveillance mission. The Air Operations Chief told us that he would like to replace the 30 OH-6A light observation helicopters in the fleet with the multipurpose MD 600N.

Concerns About the Suitability of the MD 600N Helicopter for Performing Multiple Missions

Border Patrol Air Operations officials told us that they believe the MD 600N meets the multimission capabilities specified in the contract. According to the officials, the MD 600N can (1) fly low and slow for patrol missions; (2) fly high and fast for transporting passengers; and (3) serve as a platform for mounting high-tech equipment, such as vision-enhanced cameras or FLIRs. However, most of the Border Patrol pilots with MD 600N experience that we interviewed had concerns about the multimission

capabilities of the helicopter, particularly its ability to fly low and slow. Sector chiefs are also reconsidering the multimission approach for future helicopters.

Air Operations officials stated that there is variation in the missions of the sectors. Currently the sectors operate a variety of aircraft, as was noted in table 1. The Air Operations Deputy Chief stated that a standardized fleet was desirable because it simplified the process for providing parts, maintenance, training and for other reasons.

Most of the pilots we interviewed agreed that a significant amount of their sectors' work involved flying at low speeds and altitudes performing patrol missions and that the MD 600N was not conducive to that type of flying. To effectively accomplish their mission, the pilots in one sector explained that they must fly low and slow to detect and apprehend illegal aliens hiding in canyons, bushes, and trees. These maneuvers cannot be performed as effectively and safely in the MD 600N, according to these pilots, because the MD 600N should be flown higher and faster than other aircraft to avoid the FAA-certified altitude and speed combinations (avoidance area). This area is where recovery from an engine failure might not be successful. All aircraft have an area of avoidance; however, the area is larger for the MD 600N than for the OH-6A and MD 500E helicopters (see fig. 3).

Other types of Border Patrol missions may also be limited based on MD 600N maximum weight and/or aircraft balance limits.[6] For example, using Border Patrol software provided to us by Air Operations to calculate weight and balance, we found aircraft in Deming and El Paso would be outside of acceptable ranges with a full tank of fuel, a pilot, copilot, infrared night equipment and an equipment operator. This capability was listed as requirement in the Border Patrol's solicitation for a multipurpose aircraft. Aircraft in the other two sectors would be 20 pounds below maximum weight if the unused rear seat was removed for the mission.

Several pilots noted the MD 600N, as equipped by the Border Patrol, is "nose-heavy." While flight is possible outside of approved weight and balance ranges, limits are established because an overweight or unbalanced craft can't perform as certified by the FAA. Thirty pounds of ballast, or "dead weight," was permanently installed in the tail of the Border Patrol's helicopters to try to improve on the out-of-balance

[6] The MD 600N is certified by the FAA to fly at a maximum weight of up to 4,100 pounds at density altitudes of 4,000 feet or below, and 3,850 pounds for locations above 4,000 feet. Both the El Paso sector its Deming station are above 4,000 feet. For balance, the weight must be distributed within a certain number of inches of the aircraft's center of gravity.

condition.[7] An MDH official noted that it is the 640 pounds of equipment installed for the Border Patrol—most of which is in the instrument panel—that caused the imbalance. A captain for one of the local law enforcement agencies also characterized the MD 600N as nose-heavy. The agency added ballast and moved the radios and batteries to the rear of the aircraft to compensate, according to the captain. An MDH official said that this agency added almost as much equipment to their aircraft as did the Border Patrol.

Two Border Patrol pilots suggested that the MD 600N could be an acceptable aircraft for a desert area with wide-open spaces suitable to high and fast flying. However pilots working in the desert do not believe the MD 600N is appropriate for their circumstances because they also fly low and slow. In addition, sand and dirt have caused problems with the engine. A similar problem with the OH-6A engine was handled by adding a filter, according to the Air Operations Deputy Chief. He stated that the Border Patrol plans to test a filter for certification on the MD 600N in October 2000 that might alleviate the problem.

Two patrol agents in charge stated that the variety of missions should be reflected in the aircraft for each sector. One said that the "one size fits all" (i.e., multimission) requirement does not reflect sectors' different flying environments. He does not feel that the missions will be effectively and safely accomplished as long as the policy is in effect. Another thought that every sector should have a diverse fleet of aircraft, including a few MD 600Ns for transporting "VIPs" and agents or for performing FLIR missions. He said that the bulk of the fleet should be a smaller aircraft to perform the daily Border Patrol missions.

Sector Management Questions Use of Multipurpose Helicopter

The Chief of Air Operations and some sector chiefs generally agreed that the MD 600N does provide the Border Patrol with multiple capabilities. However, given their experience to date that indicates the MD 600N may be inappropriate for a large part of their mission, sector chiefs are reconsidering whether a multipurpose aircraft is the right approach.

Border Patrol Air Operations officials stated that they wanted to procure a helicopter that had multimission capabilities. They concluded that the MD 600N could fly low, slow or fast, and carry passengers and high-tech equipment. It can perform different missions, according to the officials, by configuring each mission differently, depending on the requirements. For

[7] An MDH official stated that the addition of ballast is not unusual to compensate for the weight of equipment added by users.

example, for observation missions, a single pilot with full fuel for maximum flying hours would be possible. Or, to transport several persons or load more equipment, less fuel would be carried. According to the officials, the MD 600N in its different configurations was capable of performing everything that the Border Patrol missions require.

Several sector chiefs supported the MD 600Ns ability to support multiple tasks, but they questioned whether it was the right aircraft for all Border Patrol missions. For example, one sector chief, who was part of the MD 600N procurement team, said the goal was to give pilots the ability to support new technologies, such as FLIR and the flexibility to be able to fly low if necessary. The chief acknowledged and forwarded to an INS Western Region official the pilot's concerns about safety and handling but believes that the pilots will become more comfortable flying the MD 600N as they gain experience. However, he stated that if pilots believed that the equipment is a hindrance, then perhaps the decision to purchase more of the MD 600Ns should be reconsidered.

In another sector, the sector chief said that he thought the MD 600N was a good aircraft because it was quiet, and pilots liked how it handled in smooth air. However, they have had problems with the aircraft, as documented in several memos. The sector chief had requested additional aircraft but did not ask for MD 600Ns because he said that the aircraft had been on the ground more than they had been in the air in his sector. He said that he does not want any more MD 600Ns in his sector and recommended that the Border Patrol not purchase any more MD 600Ns until the problems are fixed.

A third sector chief said that they occasionally use the MD 600N for transporting agents in support of other operations. He also said the helicopter can get lower to see tracks. However, a memorandum from the sector regarding acquiring additional MD 600Ns stated: "Presently, the MD-600N aircraft that were acquired to replace the OH-6A helicopters have a less than 48 percent availability record. Additionally, the pilots in all operating sectors have concerns about the safety of the aircraft that are real and documented." The memorandum further states that many of the problems could have been avoided by simply asking the various sector officials what was needed for operational use in their areas.

The assistant sector chief in the fourth sector with MD 600Ns reported that about 80 percent of the sector's work was low flying patrol work but that the MD 600N was not conducive to low flying. In addition, the sector chief

said that desert conditions of the sector had caused problems for the NOTAR tail fan and the automated engine control system.

The poor reputation of the MD 600N has also extended to sectors not flying the aircraft. Sector chiefs were asked for feedback on the contents of a May 2000 memorandum from Air Operations to the Chief of the Border Patrol in which more MD 600Ns were requested. One sector chief slated to receive four aircraft, if more are purchased, wrote emphatically that the sector "does not request four (4) MD-600N helicopters." Another sector that would be assigned two MD 600Ns, if more were bought, reported to Air Operations that they did not believe the MD 600N would be effective for them. The sector official stated that they would prefer other aircraft.

While there was no consensus among managers about the role of the MD 600N for the Border Patrol, the multipurpose approach is being reconsidered. According to the Deputy Chief of the Border Patrol, a May 2000 sector-chief meeting included the MD 600N as part of a discussion of the kind of future fleet they envisioned. One sector chief at the meeting said that the chiefs supported every sector deciding what type of aircraft they needed, based on the tasks for their particular sector, rather than purchasing one multipurpose aircraft.

Many Border Patrol Pilots Lack Confidence in the MD 600N Helicopter

Pilots in all four sectors with the MD 600N reported a lack of confidence in the MD 600N because of flight safety and performance concerns. These concerns included a perceived lack of ability to successfully recover from an engine failure when flying at lower altitudes and speeds (autorotation characteristics), problems with the helicopter's electronic engine control system, control cable defects and poor flight-handling characteristics. Several pilots outside of the Border Patrol also have had some of these concerns. MDH officials stated that the autorotation characteristics of the MD 600N were approved by the FAA and that the problems with aircraft components either had been or would soon be addressed.

Concerns About Autorotation Characteristics

Most of the pilots we interviewed believed that the autorotation characteristics of the MD 600N are inappropriate for much of the flying performed during Border Patrol air operations missions. Autorotation is a pilot-recovery maneuver performed in the event of an engine failure that keeps the main rotor blades moving so that the aircraft descent can be controlled. Aircraft height and airspeed factors to be avoided during autorotation are depicted as a height/velocity curve.[8] Pilots are instructed

[8] The chances of successfully completing an autorotation are validated for a given height and speed as part of the aircraft's FAA certification. This ability differs for different aircraft and is detailed in the craft's flight manual in a height/velocity diagram. Air speed and altitude combinations where

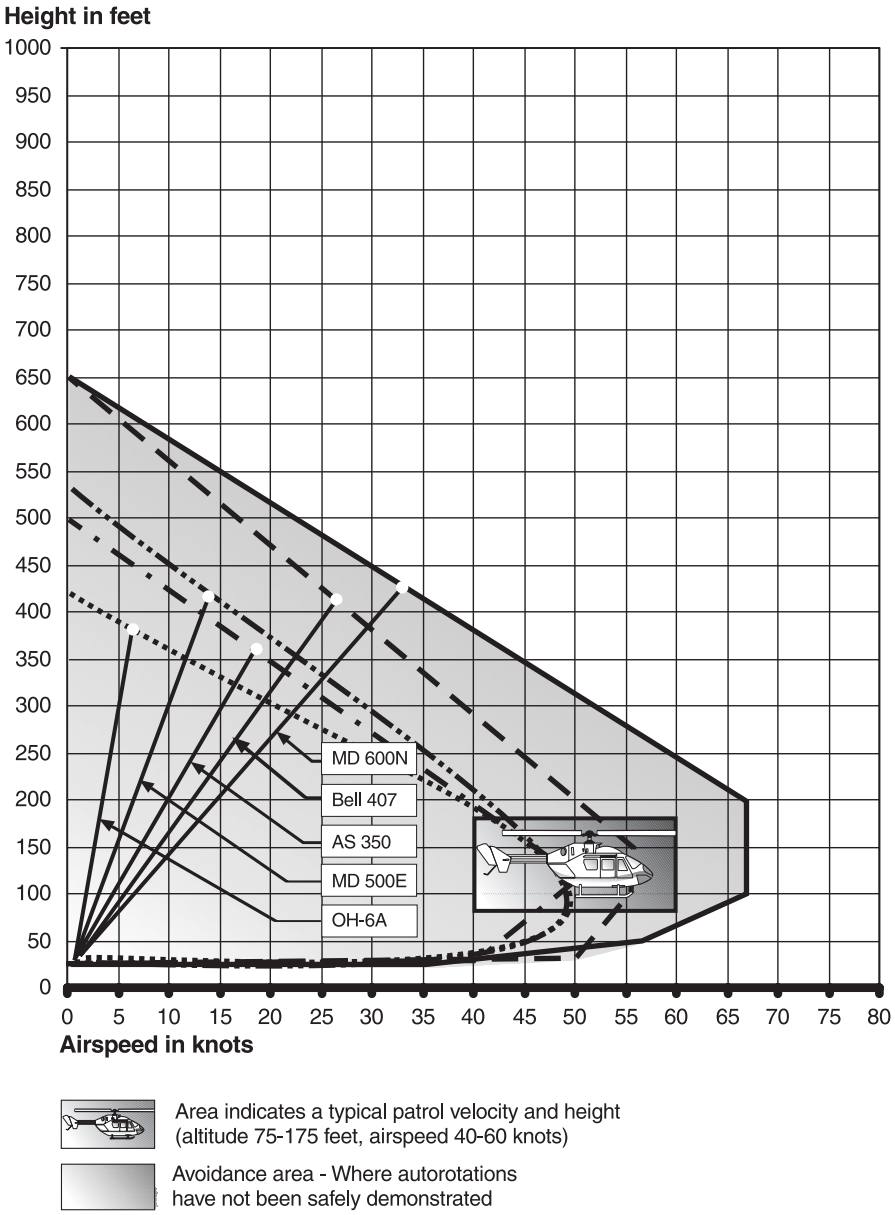
to avoid flying within the curve area, but they are not prohibited from doing so. Several pilots pointed out that the curve for the MD 600N includes more area to avoid than for some other Border Patrol helicopters, such as the OH-6A and MD 500E models. The pilots said they believed that because of the larger area to avoid with the MD 600N and its higher rate of descent, it would be more difficult to land safely during autorotation than other model helicopters.

MDH officials stated that the pilots based their concerns on a misunderstanding of the height/velocity curve rather than on the helicopter's operational characteristics. According to MDH, the MD 600N's height/velocity curve appears to cover more area because of more stringent testing conditions used for establishing the curve.[9] However, we examined the height/velocity curves for several helicopters that were tested at or estimated for sea level. The MD 600N height/velocity curve had a larger area to avoid (see fig. 3). A senior FAA certification official said that this is a valid means for showing how different aircraft height/velocity curves relate to the height and airspeed of a typical Border Patrol mission.

autorotation success has not been demonstrated are indicated as an area inside the height/velocity curve.

[9] The MD 600N was certified under part 27 of the Federal Aviation Regulations (14 C.F.R. p. 27). An MDH official stated FAR 27 requires testing to be done at 7,000 feet, while the MD 500E model was tested under an earlier regulation, that allows testing to be done at sea level, where more of the helicopter's weight is supported by denser air.

Figure 3: Height/Velocity Curves for MD 500E, MD 600N, Bell 407, American Eurocopter AS 350, and Hughes OH-6A



Note: H/V curve measured at or estimated for sea level. Helicopter weights used for the curves are 3,000 pounds for the MD 500E; 4,100 pounds for MD 600N; 5,000 pounds for the Bell 407; 4,961 pounds for the AS 350, and 2,550 for the OH-6A. Conditions assumed are that the aircraft is landing on a firm, level and smooth surface.

Source: GAO analysis of manufacturers' data.

An MDH official said they took a test pilot to one sector to discuss the autorotation concerns with Border Patrol pilots and provided additional

autorotation training to all Border Patrol sectors with MD 600Ns, at company expense. Based on feedback from Air Operations management to MDH, a company official said he believes that many of the concerns were addressed. MDH officials also said they were testing a 1 to 2 degree change in the angle of the rotor blades that will make the MD 600N easier to handle during autorotations. If testing goes well, the change will be made at no cost to customers, according to MDH officials. A proposed stability augmentation system may provide additional improvements, an MDH official said.

Several pilots also stated, however, that the manner in which the MD 600N handles could make successful autorotations more difficult, in part, because it descends faster than other helicopters, such as the OH-6A and MD 500E. According to an MDH official, the rate of descent for the MD 500E is 1,600 to 2,200 feet per minute and the MD 600N rate is 1,800 to 2,300 feet per minute or more.[10] One training pilot said the aircraft can be safely autorotated; but because it is heavier and has a higher descent rate, there is little room for error at the bottom of the descent. Pilots simulate autorecovery during training in a MDH aircraft at 3,400 pounds, according to an MDH official, although the MD 600N is certified to carry up to 4,100 pounds. Several pilots stated that they did not believe this prepared them adequately for an actual emergency. Pilots at two of the three local law enforcement agencies we visited also shared the perception of poor MD 600N autorotation capabilities.

Engine Control System Problems

Many of the pilots also did not have confidence in the electronic engine control system of the MD 600N because some of the parts have malfunctioned and because of incidents in which they believed that the system failed to operate properly. MDH and Air Operations management said that they believe that the problems have been repaired.

The engine control system for the MD 600N is a Full Authority Digital Engine Control (FADEC) system composed of two parts, an electronic control unit (ECU) and a hydromechanical unit (HMU). The ECU uses sensors to signal to the HMU how much fuel should be sent to the engine, based on automated operations or on pilot commands. The FADEC system can be switched to pilot operated (manual) mode by the pilot or by the system itself when the ECU cannot reliably gauge fuel requirements. The

[10] A memorandum from the Chief of Air Operations to one sector chief provides data putting the MD 600N rate of descent at 2,400 to 2,600 feet per minute. Although the rates are acceptable, the document notes that the descent rate is higher than past models.

Bell 407 and AS 350, similar class helicopters, also have electronic engine control systems.

Three Border Patrol sectors operating the MD 600N reported problems with the FADEC system:

- Based on recurring FADEC failures in one sector over a 4-month period, a pilot requested that its MD 600N be grounded in June 1999. The patrol agent in charge stated in a memorandum to his sector chief that "Should we experience an ECU failure at a low power setting while performing enforcement operations at low altitudes the outcome would be disastrous."[11] The source of the malfunctions was a problem known by MDH and its engine subcontractor. MDH planned to upgrade the MD 600Ns with a modified part when the components were sent in for overhaul. The sector mechanic was not given the modified part and FADEC problems continued. In the instances of FADEC failures, pilots were able to land the MD 600N safely following emergency procedures. When the engine manufacturer recognized the problem the upgraded part was provided.
- According to an Air Operations memorandum, FADEC problems in another sector in September 1999 were due to the same faulty part that caused problems in the first sector, but quick pilot action avoided any damage. After this incident, all Border Patrol MD 600Ns were upgraded with the new part.
- In the third sector, a reported FADEC problem was evaluated, but it could not be duplicated or substantiated by ground testing of the system.

Such incidents have reduced the confidence of Border Patrol pilots in the aircraft. According to the Deputy Chief of Air Operations, following an ECU failure in one sector the pilot landed the MD 600N in a field rather than fly back to the airport. The Deputy stated that he had to fly to the sector and recover the aircraft because the pilots in the sector were afraid to do so. He believes this illustrates how little pilots understand the FADEC system, in spite of the emphasis placed on training. Such failures are not a life-threatening emergency, he said.

One of the three local law enforcement agencies we visited had also experienced a problem with the FADEC system on its MD 600N. During a critical point in flight—takeoff at night—the power went to a fixed-fuel

[11] ECU failure is covered in the pilot flight manual under Emergency and Malfunction Procedures. According to the Air Operations Deputy Chief and an MDH official, an ECU failure is a standard procedure published in the pilot's flight manual and taught to pilots during their transition course, and there is no reason to believe it could be disastrous.

mode, much like a gas pedal being stuck at a high-power setting. The pilot recovered from the situation without incident.

According to MDH correspondence, as one of the first companies to integrate automated engine controls into light single-engine helicopters, some problems have occurred. The problems identified by the Border Patrol applied to all aircraft using a particular engine, including those in Bell 407 helicopters. Six of the 28 service bulletins issued by MDH on the MD 600N were related to FADEC operations. An MDH official said MDH worked with the engine subcontractor to resolve FADEC issues. All the HMU parts that were upgraded were paid for under the manufacturer's warranty. Since all MD 600Ns were upgraded with the latest parts no additional FADEC problems with the faulty subcomponent have occurred, according to the Air Operations memorandum.

An MDH official said they recognized that there was also a need for more training in emergency procedures with the FADEC system. According to an Air Operations memorandum and Air Operations officials, all sectors were provided with additional training to simulate FADEC malfunctions. The time devoted to the FADEC system in introductory training was increased; FADEC emergency procedures were to be stressed in semiannual training; and written instructions for handling FADEC failures was to be sent to all sectors.

Antitorque Problems

Many Border Patrol pilots stated that two related problems have raised concerns about the reliability of the MD 600N antitorque system: (1) defective antitorque cable components and (2) sticking or binding antitorque foot pedals. An MDH official stated that MDH is replacing the defective cable components with parts made under a revised manufacturing process and is considering how to fix the problem of the pedals sticking.

Concerns about the MD 600N antitorque cable components were raised with the 1999 crash of a MD 520N helicopter[12] and the subsequent reporting of cracks and corrosion in cable controls on a number of helicopters using the NOTAR technology. Several Border Patrol pilots and mechanics expressed concern because the same parts implicated in the crash are also used on the MD 600N. As a result of the crash, FAA and MDH issued mandatory instructions to inspect and change cable control parts on the MD 520N and MD 600N model helicopters. An NTSB investigation of the accident had not been completed; however, facts

[12] The MD 520N is a smaller NOTAR helicopter manufactured by MDH, Inc.

collected to date indicated that two cable control parts on the accident aircraft were damaged and cracked.

MDH paid for replacement of the cable control parts at no cost. Of the 109 MDH customers that confirmed their inspections to the company in writing, 48 found cable control corrosion and cracking. An MDH official said MDH believes the cracking and corrosion problem was due to an incorrect heat treatment for the parts. MDH has revised the heat treating for the cables to prevent cracking. The replacement parts have been delivered to the Border Patrol, and MDH plans to have new cables to all customers with NOTAR technology helicopters by December 2000.

A second antitorque concern was raised in two Border Patrol sectors that reported problems with "stuck pedals." Pilots use the pedals to increase or decrease the antitorque force from the NOTAR tail and in making turns during hovers. The problem reportedly occurs when a cable from the pedals and its connecting part do not align correctly and binds or sticks. Additional pilot movements reportedly cause the pedals to return to normal operation.

Mechanics in one sector were able to duplicate the stuck pedal conditions. Mechanics in another sector reported the problem to MDH and were initially told that it was a "rigging"[13] problem. However, according to an Air Operations memorandum, in both instances, the parts had not been disturbed or "rigged" since the MD 600Ns were received from MDH. An official at one local law enforcement agency said the agency had identified a way to prevent the pedals on its MD 600N from sticking, while an official at another law enforcement agency reportedly still had the problem.

An MDH official said that MDH is still looking at the stuck pedal issue. In one sector, MDH authorized tying an aluminum splint around the cables to prevent them from binding. This was considered a short-term fix, the official stated, and MDH is working with the cable vendor toward a permanent solution by the end of calendar year 2000. The splint was removed at MDH direction when the new cables were installed, according to a sector mechanic.

Poor Flight Handling Characteristics

Poor flight handling characteristics of the MD 600N are key complaints of most Border Patrol pilots. According to the pilots, heavy controls, aircraft instability—particularly during wind turbulence—and generally poor ergonomics make the helicopter fatiguing to fly. An MDH official said MDH

[13] Rigging refers to the adjustments or settings on different parts of the helicopter.

has received this feedback from several other MD 600N customers, and have proposed modifications to relieve some of the pilot's concerns.

Pilots in all four Border Patrol sectors reported that the MD 600N was heavy on the controls and very fatiguing to fly. Pilots explained that it requires a great deal of physical strength to operate the controls and that they need to constantly adjust the controls to fly "in trim." The flight test for the MD 600N procurement identified the same problem. The chair of the technical evaluation committee reported to the INS Source Selection Board that the MD 600N "control forces required to maneuver the helicopter are extreme. It is almost a necessity to use the trim motor for every movement of the controls and this increases the pilot's workload."

According to several pilots, the constant effort to fly the MD 600N limits the amount of time to about 2 hours that pilots can fly without taking a break. This was confirmed by an MDH official, who said that he had heard from other customers that 2 hours was about the maximum flight time without a break. Air Operations officials said that some Border Patrol pilots fly longer than 2 hours and should be able to fly for 4 hours without a break but could take one earlier if needed.

The heavy controls are not a new complaint, nor unique to Border Patrol pilots. This problem was identified by Border Patrol procurement test pilots in their formal evaluation of aircraft flight characteristics. FAA-certification test-pilots for the MD 600N and pilots flying MD 600Ns for a local law enforcement agency also told us that controls were heavy. The Army tested a version of NOTAR technology for its uses and rejected it. One reason was due to poor handling characteristics, according to the Test and Evaluation Officer of the Army unit and the Army evaluation report. The Army official said that the aircraft the Army tested was very different from the current MD 600N—which he has flown, but he said that the handling characteristics were similar. He said it took a lot of work to get the helicopter to do what you wanted it to do.

In addition, many of the Border Patrol pilots said that maintaining control of the MD 600N is difficult under certain conditions, particularly when it is windy. The Technical Evaluation Report for the helicopter's procurement noted similar problems. Although no overall MD 600N deficiencies were noted, the report states "Flight into high winds and gusts were tiring on the pilot. The aircraft's flying tail means the helicopter is extremely sensitive to both flight control inputs and power changes making coordinated flight difficult in high wind."

The Air Operations Deputy Chief stated that the MD 600N is certified as controllable for winds in excess of 17 knots. This certification applies for when the helicopter hovers. An FAA official said that outside of hover conditions there is no standard for stability, and approval is more subjective. FAA-certification pilots said that initially the aircraft directional control was not acceptable because of its tendency to "yaw" or turn to one side without pilot direction. A "strake"[14] was added to reduce this tendency. According to Border Patrol pilots, the MD 600N still tends to yaw at lower altitudes and speeds, which are common on Border Patrol missions.[15] At high speeds and altitudes FAA certification pilots reported that control was difficult, as did two other pilots.

To respond to Border Patrol and other customers' concerns about pilot fatigue and control difficulties, MDH proposed three modifications:

1. Adjust the engine rotations per minute to reduce the shake of the cyclic stick at ground idle. MDH plans to finish with testing of the change by December 2000 and believed that the change can be made by the engine contractor updating the FADEC software, at no cost to customers.

2. Change the angle of the rotor wings to make handling easier during autorotation maneuvers. MDH said that it will test this change in August 2000. If testing goes well, the change is to be implemented at no cost to customers.

3. To improve stability, including during wind gusts, MDH is adapting a stability augmentation system used on the MD 520N for the MD 600N. The system automates some of the control adjustments needed to keep the helicopter operating in trim. At least 30 Border Patrol pilots have tested a system prototype and gave it high ratings for improved stability and reducing the pilot workload to keep the aircraft flying in trim.[16] When testing is complete, MDH will request FAA certification for the change. As of September 2000, MDH had planned to charge

[14] Described as a "bent piece of metal that runs down the center line of the helicopter nose. The Border Patrol has replaced this piece with a wire strike protection kit that also serves the same function as the strake.

[15] The 600N flight manual warns: "An unanticipated right yaw can occur when operating at low altitude and low airspeed where a pilot, focusing his attention on surface objects may be distracted from the aerodynamic conditions affecting the helicopter's attitude. If no directional or cyclic control inputs are made, a nose down pitch and a right roll may follow the right yaw."

[16] One pilot's evaluation sheet stated: "Pilot workload reduced enabling me to devote more attention outside the aircraft to do mission."

customers about $47,000 per helicopter for the system and its installation. Border Patrol officials plan to have the system installed on all current and any future MD 600Ns.

In addition to the heavy controls, some pilots said that the MD 600N is so uncomfortable that it affects their ability to do their work. The pilots said that after 2 hours, they must stop for a break; and several said that they suffered from pain in their knees, back, and buttocks caused by uncomfortable seats. Some pilots reported using cushions provided by Air Operations headquarters or their own cushions to relieve some of the discomfort. Several pilots also said that visibility is limited because of the door frames, particularly while using the cushions. They reported that they must get in awkward positions to look at objects below or behind them.

Figure 4: MD 600N Ergonomics

(A) Pilots explained that visibility is limited by the door frames, and that awkward positions are sometimes necessary to see objects below or behind them.

(B) Some pilots reported using seat cushions provided by Air Operations headquarters or their own cushions to relieve some of the discomfort caused by the seats in the MD 600N.

Source: GAO.

Air Operations officials agreed that the seats in the MD 600N are uncomfortable. Pilots had said they wanted padded seats, so the officials said they asked for high-quality seats during the procurement.[17] Air Operations officials recently took action to replace the seats provided under the original procurement. Seats tested by Border Patrol pilots during the flight evaluations for the stability augmentation system have been ordered and are being manufactured, as of September 21, 2000, according to INS.

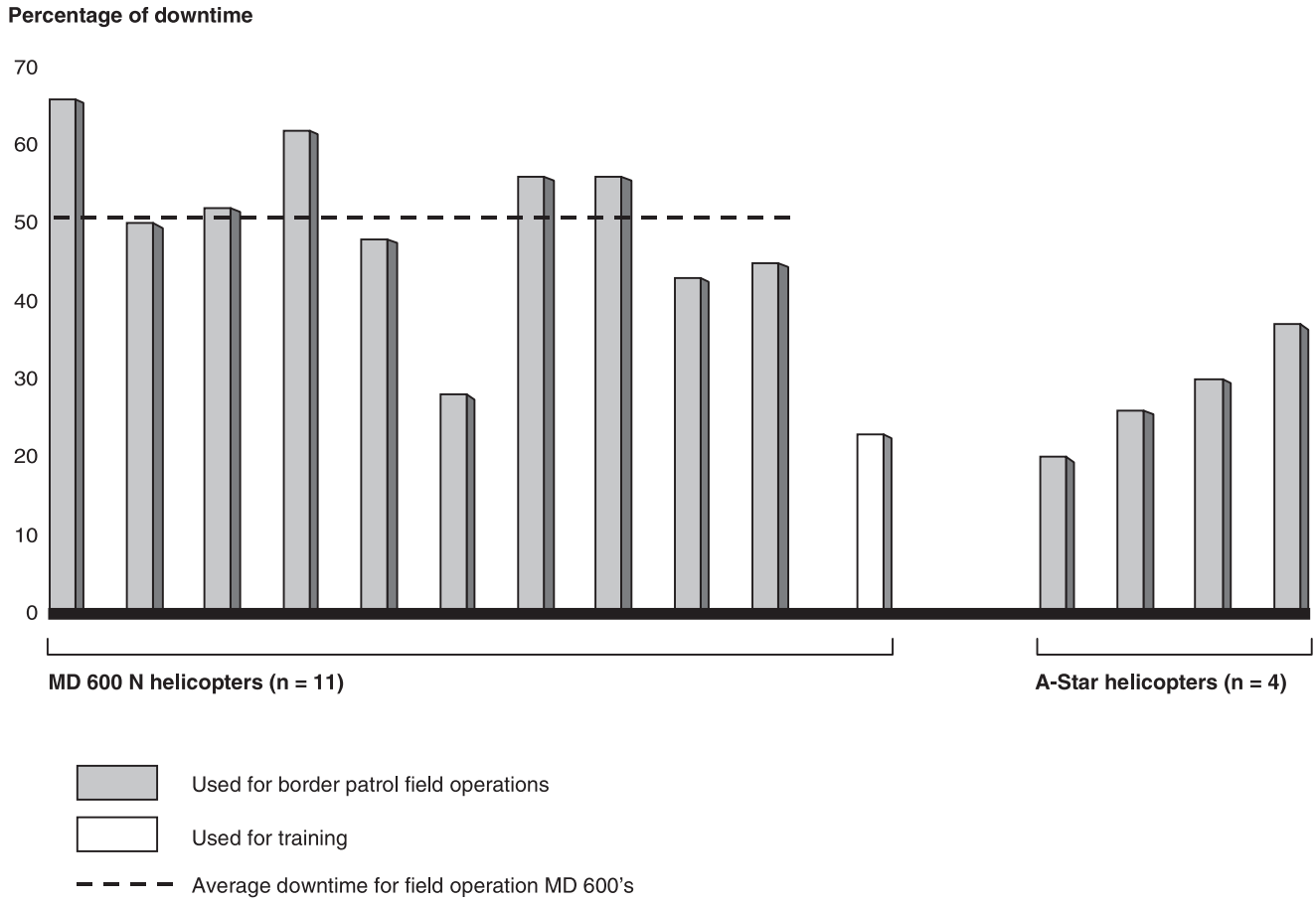
MD 600N Availability and Maintenance Concerns

A major concern of most sector chiefs and their staffs was the significant amount of time in which the MD 600N helicopters were unavailable for use or "down." Air Operations records for December 1998 to March 2000 show that the 10 MD 600Ns assigned to Border Patrol field operations were unavailable, on average, over 50 percent of the time.[18] This downtime included any time that the helicopters were not operational due to avionics repair, maintenance, or while waiting for parts. In comparison, the four Border Patrol Eurocopter "A-Star" helicopters were down 28 percent of the time during the same period. Reasons for the downtime included delays in obtaining an engine repair contract, slow manufacturer approval for modifications, and parts availability.

[17] The helicopter solicitation listed as a desirable cabin feature for the offerer to include pilot and copilot seats that are padded and have lumbar support. The seats on the MD 600N are padded but have no lumbar support.

[18] The eleventh Border Patrol MD 600N is assigned to Air Operations and is used mainly as a training vehicle by instructor pilots. It does not fly sector missions on a regular basis and has flown fewer hours than the field helicopters. It was unavailable about 25 percent of the time.

Figure 5: Downtime for Border Patrol 600N Helicopters



Source: GAO analysis of Border Patrol Air Operations data.

The consequences of the MD 600N helicopters not being available were greater in sectors without other helicopters in their inventory. For example, during our visits to two sectors, all six of the MD 600Ns were unavailable. One of the sectors had OH-6A helicopters for backup, but the other sector's single backup OH-6A was awaiting an engine, leaving the sector without any helicopters. The patrol agent in charge said that with no working helicopters, ground agents' requests for assistance could not be supported, including an incident where an agent was being fired on by armed drug smugglers.

An Air Operations official said that specific helicopters may have had problems that explained why they were inoperable. The official stated that, for example, two MD 600Ns were down due to foreign object damage to

the engines. The damage was discovered in November 1999, but the helicopters were not returned to service until March and April 2000, respectively, because Air Operations was without an engine repair contract from October 1999 to June 2000. Emergency engine repairs were requested in late November but not authorized until mid-February 2000.

In response to our questions about MD 600N availability, Air Operations officials directed a review in one sector on availability and possible reasons for delay. The resulting report stated that for two aircraft they could find no documentation justifying the reasons why they were out of service for extended periods. Also, concerns were raised that mechanics were charging time to a designated aircraft in the sector's fleet whether they were working on that particular aircraft or not. The report noted that repairs and incorrect part numbers caused some delays but did not explain what appeared to be excessive maintenance time.

A written response by the patrol agent in charge from the sector reviewed disputed the findings of the maintenance review, stating that the down time of the aircraft is warranted due to untimely provision of parts, repairs, and waiting for authorizations to make modifications. For example, according to the response, one aircraft was down waiting for control stick modifications for many weeks. The parts were sent to an MDH subcontractor; and when the parts were returned, they had to be sent back because the work was incomplete. Regarding mechanic time charges, the response agreed with the Air Operations description of how mechanics accounted for their time but pointed out that their accounting did not differ for the MD 600N and other aircraft. According to the response, excessive maintenance time was where additional work was needed.

An MDH official also said that he was unaware of any reason for the Border Patrol's MD 600Ns to be sitting on the ground. In contrast to the Border Patrol 's experience, the MDH official stated that one local law enforcement agency has had no problem with downtime for their two MD 600Ns. Officials from that agency confirmed the MDH statement and said that maintenance downtime for their MD 600Ns is lower than they experienced with their prior helicopters. An MDH official reported that a simple analysis of their data showed that parts for the MD 600N provided under warranty in 1999 took an average of 2 days to obtain.[19] We were unable to reconcile Air Operations and sector data on the provision of parts not under warranty or parts sent for repair.

[19] All warranties for the 11 Border Patrol aircraft have expired, with the exception of specific parts with warranty limits based on flight hours.

However, Border Patrol mechanics in all four sectors attribute excessive downtime for the MD 600N to a multitude of problems they have had with the aircraft. For example, in a memorandum to the chief patrol agent in one sector, a mechanic described the problems with the MD 600N: "Since the delivery of this aircraft we have continually experienced serious malfunctions. Some of the more recent malfunctions that come to mind would include executing an emergency landing due to an indication of an electrical fire, fuel found leaking through a wiring harness, and severe engine compressor erosion, with a repair cost in excess of $74,000."

Scheduled maintenance has also taken longer than the manufacturer's estimates, according to several mechanics. MDH estimates for periodic inspections do not account for the time needed for repairs, parts replacement, or other work, explained one patrol agent in charge. Pilots and mechanics in three sectors said that when the MD 600Ns have gone down for scheduled maintenance and are taken apart, problems not expected have been found that must be fixed before the aircraft are returned to service. Several mechanics noted that without strong technical support from MDH, they spend considerable time troubleshooting. Maintenance time is unusually high, even considering the newness of the MD 600N, several mechanics stated.

One patrol agent in charge and mechanic agreed with Air Operations officials that most parts in stock were delivered quickly, they also said that not all parts requested were delivered in a timely manner. For example, in one sector a toggle switch took 41 days to arrive.[20] The Assistant Chief of Air Operations agreed that this was excessive. Air Operations could have authorized a local purchase of the part, but did not do so despite calls from the sector regarding the status of the part, according to the sector's maintenance supervisor. The Assistant Chief said that Air Operations may not act right away when a part is requested. For example, they might research the part or may wait and order a number of parts at once. Sometimes it can take a month to get a part, the Assistant Chief said.

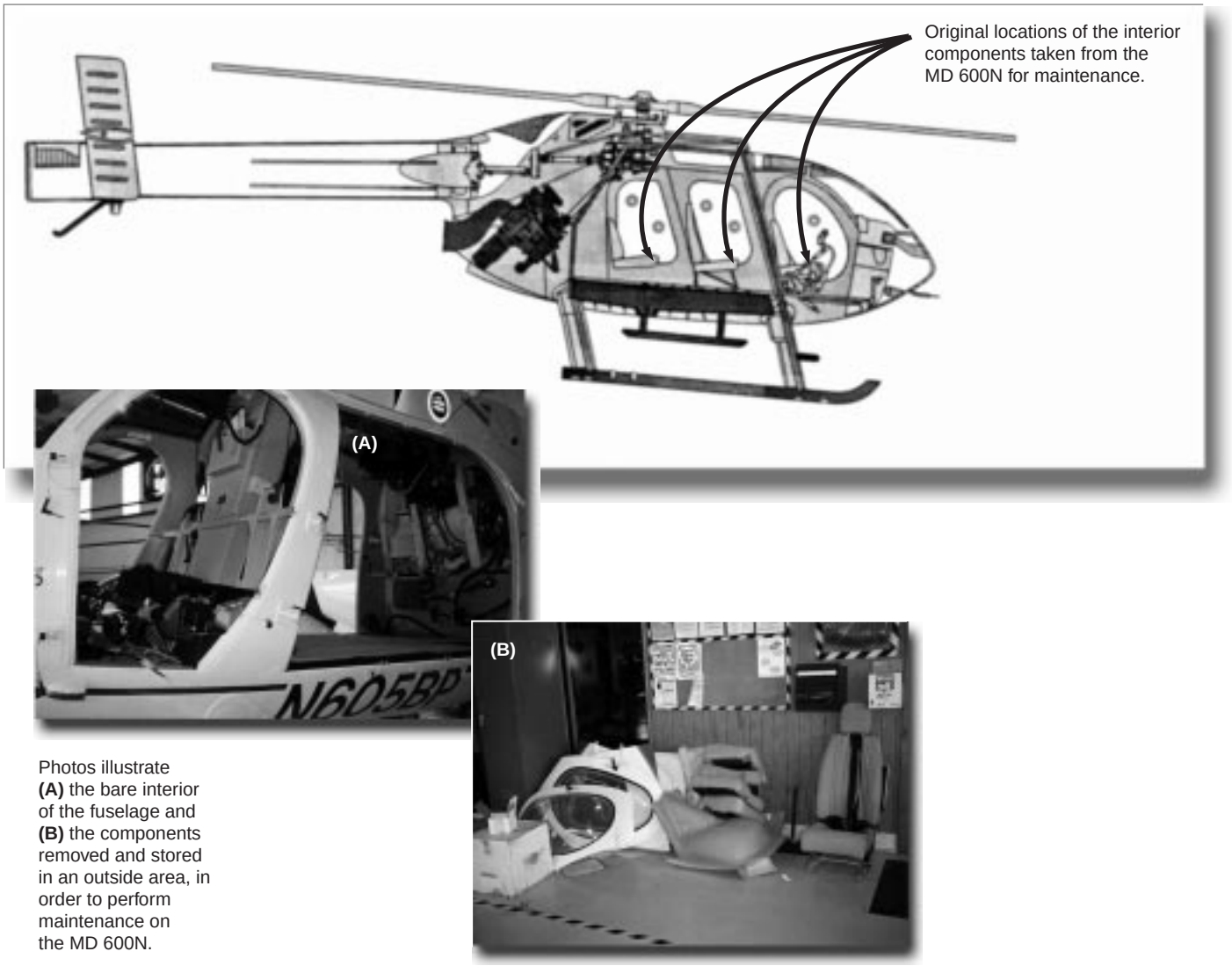
Mechanics in two sectors said that the time necessary to have components repaired could also be lengthy. For example, in one sector, a part was leaking oil and was sent to MDH for repair. It was over 2 months before the part was returned. Another sector reported that 3 days into a routine 300 hour inspection, the horizontal stabilizer was found to be damaged. It was submitted for repair in mid-September 1999, and was not returned

[20] The part was requested under priority "03," which is for parts needed within a minimal time and scheduled for delivery within 8 days.

until late December 1999. The Air Operations Deputy Chief said that the cause of the damage was investigated; and when new fiscal year funding was received, the part was repaired.

Finally, mechanics in two sectors said that the design of the helicopter makes working on it time consuming because many repairs require that the aircraft be taken apart. One mechanic stated, for example, that often carpet must be pulled up, seats removed, and the interior vinyl removed in order for mechanics to access the aircraft's parts for a 100-hour inspection. Helicopters by other manufacturers, such as Bell, have their transmissions and drive trains located externally and would not need to have the interiors removed for a routine inspection, he said. The interiors have also experienced unusually high levels of wear and tear because of the need to remove them, one mechanic said.

Figure 6: Aircraft Repairs Often Require Interior to Be Removed



Photos illustrate **(A)** the bare interior of the fuselage and **(B)** the components removed and stored in an outside area, in order to perform maintenance on the MD 600N.

Source: GAO Photo.

Technical Support Reported as Not Always Helpful

While mechanics in one sector praised MDH's technical support for the MD 600N, saying that the technical representative has made every effort to accommodate them, the other three sectors voiced a number of criticisms.

MDH officials and Air Operations management stated that technical support and service for the MD 600N suffered during the transitions from McDonnell Douglas to Boeing and then to MDH. MDH officials said that

since then, they have made personnel changes, retained many staff with MD 600N experience, and have a representative devoted to Border Patrol part requests. The company plans to outsource work such as the fuselage, according to an MDH official to improve the cost-effectiveness of some parts. To improve the efficiency of supplying parts, MDH has also begun to expand its parts inventory. An MDH official said that he was not aware of some of the problems expressed by Border Patrol mechanics and said that MDH cannot address concerns unless it hears about them.

Some improvements in customer service have been noted; however, mechanics continued to report weak technical support. One sector mechanic reported that when a senior technical representative was involved with a trim motor problem in July 2000, the representative was very concerned with fixing the problem and saw that it was resolved. However, the same mechanic was called in June to repair a MD 600N stranded in the field where it had landed to assist agents with 14 illegal aliens. The technical representative couldn't explain why there was a problem or how to fix it, the mechanic said. Eventually, the mechanics "hot wired" the aircraft to bring it back to the hangar.

In another sector in June, 2000, structural cracks and buckling in the airframe of an MD 600N developed, according to a memorandum to the sector chief. The sector mechanic said that MDH and Air Operations officials suggested that he put a "patch" on the area. The mechanic did not believe this was appropriate and asked for MDH engineers to document that such a repair would be structurally sound. Repair instructions from MDH were received on July 21, 2000. Air Operations then decided that factory officials should determine the cause of the crack, and it was removed from the sector. A report from MDH on the damage stated that a large depression/dent near the crack was not considered typical and that a visual examination of the area suggested damage resulted from an impact of an external object. An FAA-certified repair was completed by August 22, 2000, at the MDH factory. The patrol agent in charge strongly disagreed with the characterization of the damage. He noted that several mechanics and pilots looked at the area for damage before the helicopter was taken to the factory; and none was evident except for the buckling and cracks. A third sector also reported similar dissatisfaction with MDH's technical support.

Conclusions

Helicopters play an essential role in supporting the Border Patrol's overall mission. The variety of helicopters currently in the Border Patrol fleet perform various missions that require long periods of surveillance; mountain operations; night surveillance, using vision enhancement

equipment; and high-speed transportation of agents and/or equipment to remote sites. The bulk of their work involves surveillance at low altitudes and speeds. The majority of the Border Patrol's helicopters, however, are over 35 years old.

The procurement of the MD 600N was based upon the premise that one helicopter type would be appropriate to meet a variety of air operations needs in the various sectors. Only two of the six aircraft originally considered were evaluated as meeting the solicitation requirements for such a multipurpose helicopter. While the MD 600N technically meets the range of air operations requirements, it may not be the best choice in filling specific needs of each sector.

Border Patrol pilots, mechanics, and sector managers lack confidence in the ability of the MD 600N to safely, efficiently, and reliably perform. Pilots have experienced problems with the electronic engine controls, antitorque cables, and are concerned about their ability to safely autorotate the aircraft. The MD 600N has proven difficult to handle and fatiguing to fly—weaknesses that were evident before the aircraft was purchased. Mechanics document numerous problems they have encountered in keeping the aircraft operating. The aircraft have been down, on average, half the time, and this is a problem recognized by sector chiefs, pilots, and mechanics.

Testing is under way for several MD 600N modifications to improve the performance of the aircraft. Most notably, the stability augmentation system may greatly improve MD 600N stability and reduce some pilot workload. Redesigned cables and FADEC parts, the addition of an engine filter, and new seats may also address some problems. However, other issues remain. Whether the MD 600N is suitable for meeting all mission requirements—particularly for low speed and low altitude work, remains a question. The improvements also do not address pilot lack of confidence in the safety of the aircraft and limited aircraft availability.

Recommendations

We recommend that before any more MD600Ns are purchased, the Commissioner of INS require Border Patrol officials to address with MDH the safety, handling, and availability issues raised by pilots and mechanics. We also recommend that the Commissioner require the Border Patrol reassess its decision to purchase one multipurpose helicopter to meet a variety of air operations mission requirements.

Agency Comments and Our Evaluation

INS' provided written comments on a draft of this report. In its general comments, which are included as appendix I, INS stated that it concurred with our recommendations and that the issues covered in our report were not unknown to the program. With regard to the safety, handling, and availability issues, INS stated that steps are already being taken to ensure that these concerns are fully addressed prior to additional aircraft procurement. INS pointed out that it is testing a stability augmentation system to ease pilot workload concerns and to improve aircraft handling. It is also providing a new seat to increase pilot comfort, and is testing an engine filter to improve aircraft performance under sandy conditions. We believe these are steps taken in the right direction. However, concerns surrounding suitability of the aircraft for typical Border Patrol missions and the availability of the aircraft require further attention.

INS also agreed with our recommendation to reassess the decision to purchase one multipurpose helicopter to meet a variety of air operations mission requirements. However, regarding the sector-by-sector analysis of terrain, flying conditions and mission requirements that as we had suggested in the draft report, INS said that the analysis is part of its historical support function. With its comments, INS provided memorandums from 1994 and 1995 that showed that each sector provided information to Air Operations that helped to establish sector requirements. These requirements included low and slow flight operations, long-range and improved night operations capabilities. Therefore, we have modified our recommendation and various sections of the report to reflect this information.

INS also provided specific and technical comments that amplified points in its general comments. Many of these comments took issue with our findings relating to suitability, safety, handling, comfort, and availability. Regarding suitability of the aircraft to perform light duty observation missions, INS stated the MD 600N is a medium-sized aircraft that fulfills requirements between the light observation OH-6A aircraft and heavier duty aircraft. Further, INS stated that three sizes of helicopters will be needed to meet the mission requirements. INS said that the MD 600N has not replaced smaller aircraft and would not do so as long as the smaller aircraft are supportable. These statements are inconsistent with INS' earlier positions. INS procurement documents and budget requests show that (1) the MD 600N is a multipurpose aircraft capable of operating in a wide range of Border Patrol scenarios, including light observation missions and (2) INS was anticipating procuring as many as 45 MD 600N helicopters to replace the majority of the 57 helicopters currently in its fleet. Further, a May 2000 memorandum from the Chief of Air Operations

stated that the MD 600N is intended to replace the light observation OH-6A aircraft. Nevertheless, if INS' comments reflect a change in position, then these seem to be steps in the right direction toward meeting our recommendation of reassessing the decision to purchase one multipurpose helicopter.

INS raised an issue concerning what portion of the Border Patrol air mission involved low and slow flying. It stated that a large percentage of its current mission profile is in the light category because over 60 percent of their current fleet are light category aircraft that are capable of little else. However, both Border Patrol pilots and Border Patrol sector requirement memorandums identify low and slow flying as a primary mission requirement. Therefore, the Border Patrol needs aircraft that are suitable for the low and slow mission.

Regarding safety, most of INS' comments related to a comparison of the height-velocity curves of the MD 600N and those of other aircraft (see fig. 3). INS stated that the figure portrays the MD 600N as less safe because of its larger height-velocity avoidance area (the combination of altitude and airspeed where an autorotative landing might not be safely made). Our portrayal was meant to show where a typical mission falls in relation to the avoidance areas of the different aircraft. According to INS' Air Operations Manual, operations in this area should be avoided or limited to the minimal amount necessary to complete operational maneuvers. Figure 3 shows that a typical patrol mission falls entirely within the MD 600N's avoidance area, but only partially within this area for the other aircraft. This is a valid means for comparison, according to a senior FAA official, as is noted in our report.

INS commented that FAA certified the MD 600N as to airworthiness and safety. Our report does not question the aircraft certification. Rather, given the fact that a typical mission profile requires flying in the MD 600N's avoidance area, we question the appropriateness of the MD 600N for the work.

Concerning handling and comfort, INS noted that several improvements are under way, such as the addition of the stability augmentation system and redesigned seats. They also provided information showing that these improvements were well received by the pilots that tested them. These improvements are noted in our report. INS also took issue with our characterization of the MD 600N as cramped and uncomfortable and provided a comparison with the other aircraft deemed acceptable in the procurement competition. The cramped conditions inside the aircraft, as

described in our report, were abstracted from formal procurement evaluation documents prepared by Border Patrol pilots. Cramped conditions were not attributed to the other aircraft in the final competition.

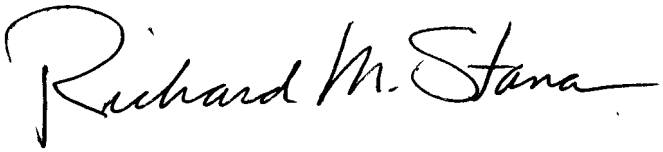
Concerning availability, INS stated that our chart showing the limited availability of the MD 600N is misleading because 20 percent of the MD 600N fleet (two aircraft) were unavailable for 5 months due to engine repair contracting delays. We acknowledged this point in the report. Nevertheless, our analysis for the 18 months we reviewed showed that the MD 600N fleet was not available for field operations at least 50 percent of the time. INS noted that the availability of aircraft is an interdependent relationship of maintenance performance by the sector, technical support, and parts availability; and they will continue to strive for excellence in each of these areas.

INS also provided additional information, which we have evaluated and included in the report, as appropriate.

Copies of this report are being sent to Senators Orrin G. Hatch and Patrick J. Leahy, Chairman and Ranking Minority Member of the Senate Committee on the Judiciary; Representatives Henry J. Hyde and John Conyers, Jr., Chairman and Ranking Minority Member of the House Committee on the Judiciary; Senators Ted Stevens and Robert Byrd, Chairman and Ranking Minority Member of the Senate Appropriations Committee; Representatives C.W. Bill Young and David Obey, Chairman and Ranking Minority Member of the House Committee on Appropriations; Senators Fred Thompson and Joseph Lieberman, Chairman and Ranking Minority Member of the Senate Governmental Affairs Committee; and Representatives Dan Burton and Henry Waxman, Chairman and Ranking Minority Member of the House Government Reform Committee. We will also send copies to the Honorable Janet Reno, the Attorney General and the Honorable Doris Meissner, Commissioner, Immigration and Naturalization Service and others upon request.

The major contributors to this report are acknowledged in appendix II. If you or your staff have any questions on this report, please call Darryl Dutton on (213) 830-1000, or me on (202) 512-8777.

Sincerely yours,



Richard M. Stana
Associate Director
Administration of Justice Issues

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Abbreviations

ECU	electronic control unit
FAA	Federal Aviation Administration
FADEC	Full Authority Digital Engine Control
FLIR	forward-looking infrared
HMU	hydromechanical unit
INS	Immigration and Naturalization Service
MDH	MD Helicopters Incorporated
NOTAR	Patented name for MDH no tail rotor antitorque system
NTSB	National Transportation Safety Board

Comments From the U.S. Department of Justice

U.S. Department of Justice
Immigration and Naturalization Service

HQBOR 100/8.1-C

Office of the Executive Associate Commissioner

425 I Street NW
Washington, DC 20536

SEP 2 1 2000

Mr. Richard Stana
Associate Director
Administration of Justice Issues
U.S. General Accounting Office
441 G Street, NW
Washington, DC 20548

Dear Mr. Stana:

In reference to the General Accounting Office (GAO) draft audit report entitled *Border Patrol Procurement of MD 600N Helicopters Should Be Reassessed* (GGD-00-201/183641), the Immigration and Naturalization Service (INS) concurs with the report and the one recommendation contained in its conclusion:

> "We recommend that before any more MD 600Ns are purchased, the Commissioner of INS require Border Patrol officials to address with MDH the safety, handling, and availability issues raised by pilots and mechanics. We also recommend that the Commissioner require the Border Patrol reassess its decision to purchase one multipurpose helicopter to meet a variety of air operations mission requirements. As part of this reassessment, the Border Patrol should do a sector-by-sector analysis of terrain, flying conditions and mission requirements to identify the most appropriate type or types of aircraft to meet their operational requirements."

The enclosure, prepared by the Chief of the U.S. Border Patrol, provides general comments and comments on specific sections of the draft report. Please incorporate these comments into

Mr. Richard Stana
Page 2

the GAO final report. If you have any further questions, please contact Assistant Chief Randy Gallegos, Headquarters Border, at 202-353-7226. Thank you for the opportunity to provide comments.

Sincerely,

Michael A. Pearson
Executive Associate Commissioner
Office of Field Operations

Enclosure

COMMENTS ON THE GAO DRAFT REPORT: GGD-00-201

GENERAL COMMENTS

The referenced United States General Accounting Office (GAO) report, *Border Patrol Procurement of MD 600N Helicopters Should Be Reassessed,* was prepared for Congressman Duncan Hunter. The report contains one recommendation in its conclusion:

"We recommend that before any more MD 600Ns are purchased, the Commissioner of INS require Border Patrol officials to address with MDH the safety, handling, and availability issues raised by pilots and mechanics. We also recommend that the Commissioner require the Border Patrol reassess its decision to purchase one multipurpose helicopter to meet a variety of air operations mission requirements. As part of this reassessment, the Border Patrol should do a sector-by-sector analysis of terrain, flying conditions and mission requirements to identify the most appropriate type or types of aircraft to meet their operational requirements."

The INS concurs with this recommendation. The issues discussed in the GAO report were not unknown to the program. The Chief of Air Operations, Douglas Keim, has already taken significant steps to ensure that MD 600N concerns are fully addressed prior to additional aircraft procurements. The GAO report, while publicly describing the internal issues surrounding the MD 600N, does not ask the INS to do anything more than responsible management would dictate.

The GAO report, taken in its entirety, indicates a lack of confidence among Border Patrol pilots in the operational abilities of the MD 600N. While this lack of confidence is impossible to scientifically quantify, it is nonetheless a critical factor in the future utility of the aircraft. Helicopters are an essential part of our border enforcement efforts, and we have no interest in acquiring aircraft that our professional pilot corps deems unsuitable or unsafe.

Chief Keim was tasked with responding to the GAO report within the program. He has addressed the issues outlined in the report and provided some insight regarding portions of the report that may be substantially or technically inaccurate. Portions of Chief Keim's report follow:

The MD 600N was fielded by the U.S. Border Patrol just as the manufacturer was being sold. The new owner announced the intention to sell the light helicopter division, which included the MD 600N product line, and retain the AH-64 Apache military attack helicopter. This ushered in a period of uncertainty and less than commendable product support as employees left the uncertain future of the light helicopter division in favor of the Apache program. The light helicopter division was then purchased by MD Helicopters, Incorporated. The new company made customer support a high priority, though still dependent upon the previous owner to provide support in some areas, such as replacement parts and technical support, while establishing itself and gaining the facilities and personnel necessary to become completely self-sufficient. During this transitional phase, the refinements required in any new aircraft design were being identified by customers in day-to-day use of the newly certified MD 600N.

Foremost among these concerns was increased pilot workload when compared with other light helicopters produced by the company. Compared with the sports-car-like OH-6, which constitutes the bulk of the Border Patrol fleet, it was something different. This utility was exactly what was sought in the solicitation for proposals because it was the area in which the Border Patrol fleet was most deficient. As an agency, we lacked the ability to support the use of modern sensing and recording equipment that would both allow around-the-clock enforcement efforts and free our pilots from the necessity of operating in the most dangerous environment close to terrain and obstacles at very low speeds. During this time period, the Service was also acquiring night vision goggles and Infrared Imaging Devices for use by ground agents in an attempt to enhance our land-based night enforcement efforts. In comparison, the OH-6 normally can carry one pilot or a pilot and one additional person. This greatly limits its ability to support modern sensing equipment, perform maintenance of radio repeater sites, conduct external load operations, or simply transport nonenforcement personnel because it is not certified and can legally perform only "Public Use" missions.

Reluctance to embrace change is not unique to this aircraft. When the OH-6 was first introduced, our pilots initially rejected it as unsafe because it was military surplus and not certified by the Federal Aviation Administration (FAA). The belief at the time was that we should continue to exclusively utilize the Piper Super Cub airplane. In time it became apparent that helicopters were vastly superior to fabric-covered airplanes for most of our missions.

The AS 350 "A-Star" helicopter, built by American Eurocopter, also met a negative reception for the first few years after acquisition until being centralized in Del Rio, Texas, where, in the absence of other helicopters and after enhancements by this office, it has proven itself to be a very capable aircraft. It initially suffered maintenance problems, which adversely affected availability. Training of maintenance personnel and improvements in support corrected this situation, just as they have in the case of the MD 600N.

The GAO report recommends that the Air Operations Center and MD Helicopters (MDH) address the safety, handling, and availability issues raised by pilots and mechanics prior to purchasing additional aircraft.

The U.S. Border Patrol and MDH have been diligently addressing those concerns in a cooperative effort from the beginning. The Stability Augmentation System (SAS), currently undergoing the certification process, will address the pilot workload concerns and make the aircraft handle similar to those half its size according to the critiques of over 50 Border Patrol Pilots who have evaluated the system thus far. A new seat design has been perfected and purchased and is in production at this time to allow the pilots to have greater visibility and comfort. The new seat has received unanimous endorsement by the same pilots who have evaluated the SAS system. Certification testing for a barrier filter to allow the engine to operate in a sand-laden environment is scheduled to begin in October 2000. This is the same type of system developed here at El Paso Flight Operations (EFO) for our OH-6 helicopters, and it has saved tens of thousands of dollars in reoccurring maintenance. The upgraded potentiometers were installed in every Border Patrol aircraft as soon as the agency became aware of the problem, and no Engine Control Unit failures have occurred since that time.

2

The availability issue as outlined in the GAO report does not sufficiently explain how contracting and procurement issues have affected aircraft usage. Foreign object damage to two engines (25 percent of the fleet at that time) during a period of time when no contract was in place to repair the engines caused extraordinary delays. Inaccurate reporting of downtime by one sector also affected usage rates.

The FAA is the sole authority in this country for determining the safety and airworthiness of aircraft. The FAA has certified the MD 600N to the most recent and stringent criteria ever used by the Government. Since the fielding of the MD 600N and after over 7,000 flight hours by Border Patrol pilots, the only incident resulting in any damage to the aircraft was as a result of the pilot failing to recognize a failure and execute the published emergency procedure. He landed the aircraft without any damage to the airframe or occupants other than those components that had to be replaced because of an overspeed of the rotor system. Portraying the MD 600N as less-than-safe is without basis in fact. This aircraft and all the variants of the MD 500 family have proven themselves to be among the most crash-survivable aircraft available. This is primarily due to the "A" frame truss assemblies incorporated into the design of the fuselage.

Any helicopter used for tracking is in the "avoid" area of the Height/Velocity curve described in the GAO report. This curve simply indicates a combination of altitude and airspeed from which, in the event of an engine failure, damage to the aircraft may occur in spite of the best efforts of the pilot. Throughout the history of Border Patrol aviation, there have been numerous occasions when a helicopter pilot had to perform an autorotative landing. Of these situations, only one failed to sustain damage to the aircraft during the landing. None of these situations resulted in a fatality.

The GAO recommends that this agency reassess its decision to purchase one multipurpose helicopter to meet a variety of air operations mission requirements. We agree, and we had multiple discussions with GAO personnel regarding this issue.

The air operations center has asked for funding for the acquisition of twin engine helicopters for some time. During this same period of time, we have continued to build small OH-6 observation helicopters by retrofitting surplus military fuselages. The MD 600N is the medium-sized aircraft between the light observation platform and the twin engine utility aircraft. The MD 600N is capable of supporting modern night vision goggles, forward looking infrared (FLIR) systems, and high magnification camera and recording equipment and can carry the crewmembers to operate them. It can perform external load operations to transport contraband or recover disabled all-terrain cycles, yet it can still perform the mission of the smaller observation platform when required. The twin engine aircraft are needed to support other specialized missions: over-water operations, search and rescue of migrants in distress, heavy external loads for construction of radio repeater sites, and tactical operations among them. As indicated, at least three sizes of helicopter will be required to meet the mission requirements of the Border Patrol. The Air Operations Center is well aware that no single aircraft can perform all the required missions. A twin engine helicopter is too large to be effectively employed as a tracking platform. The small observation helicopter cannot carry sensor equipment or multiple passengers. It is prudent however, to acquire an aircraft that can meet as many mission requirements as possible. It is not difficult to see why a large percentage of our current missions

are in the light category, when it is taken into consideration that over 60 percent of our current fleet is capable of little else. Currently, only 50 percent of our twenty-four-hour enforcement requirement is being met.

A section of the GAO report is unclear. In one paragraph on the second page, the report states that the MD 600N cockpit is cramped. In the following paragraph the report indicates that a smaller aircraft is desirable. It is certain that our fleet of 35-year-old surplus helicopters must be replaced. However, a much broader mission than single pilot daytime operations must be used for suitability analysis.

The GAO recommends that a sector-by-sector analysis of terrain, flying conditions, and mission requirements be done to identify the most appropriate type or types of aircraft to meet operations requirements. The staff at the air operations center are all career Border Patrol Agents who were promoted from the ranks of Border Patrol Pilots. They have flown in every sector on the southern border and are intimately familiar with the terrain and varying enforcement strategies being employed in each. Annual site visits to each sector are conducted to ensure that the air operations staff are aware of any change in the sector enforcement strategy and to see that the needs of each particular sector are being met.

These visits consist of meetings with the sector staff who direct the sector's enforcement efforts as well as with the pilots who perform them. The analysis that GAO recommends is part of our historical support function and these efforts will continue.

GAO Contacts and Staff Acknowledgments

GAO Contacts

Richard M. Stana, (202) 512-8777
Darryl W. Dutton, (213) 830-1000

Acknowledgments

In addition to those named above, Monica Kelly, Bunnie Lempesis, John P. Swain, Katherine M. Raheb, Michael P. Dino, Ann H. Finley, and Adam Vodraska made key contributions to this report.

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